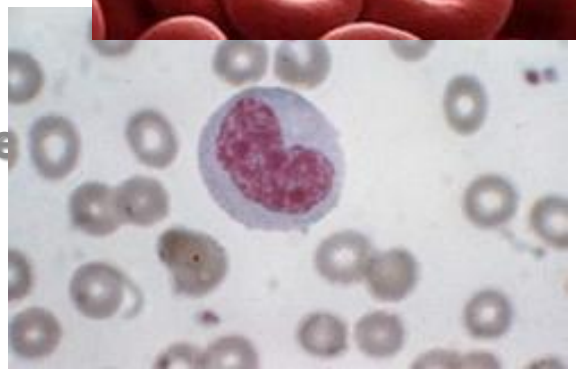
# Ch 18: Blood

- Discuss the composition of blood including the functio of the various components
  - Explain the anatomy and functions of the red blood cells, including a description of blood typing
  - Discuss the types of white blood cells found in the blood and give the functions of each
  - Give a brief accounting of platelets
- Review hemopoiesis, including RBC and leukocyte formation

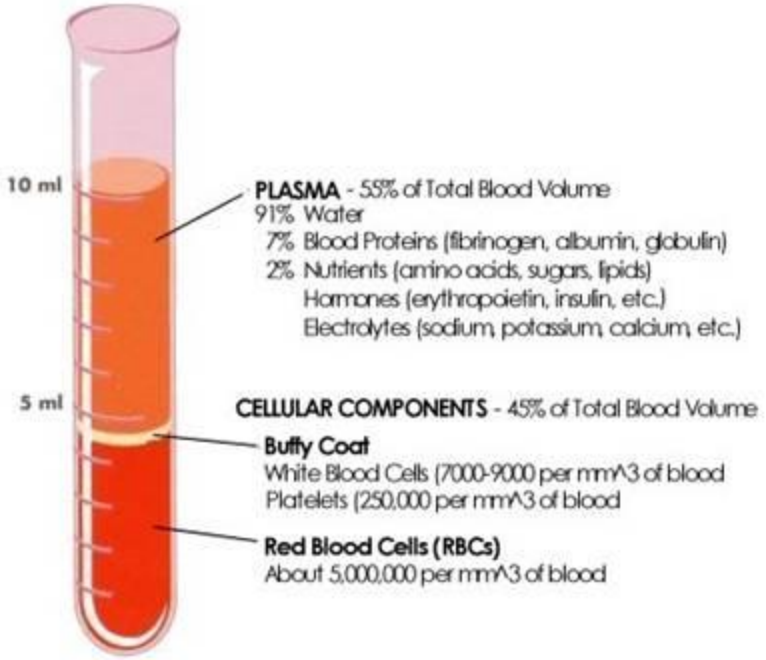


Developed by
John Gallagher, MS, DVM

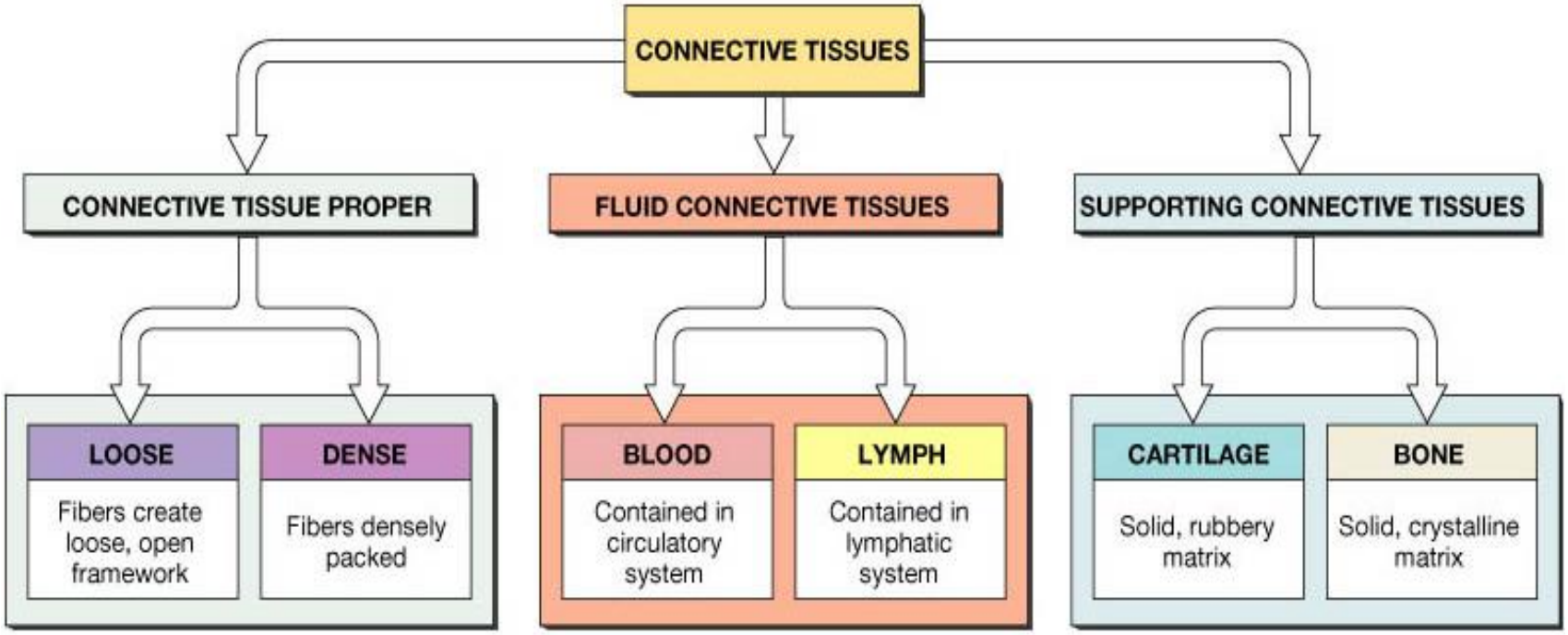
LAS POSITAS COLLEGE

# Functions of Blood

- **Distribution/transport - nutrients, wastes, gases, etc.**
- **Communication, i.e., hormones**
- **Prevention of fluid loss – hemostasis, osmosis**
- **Maintenance of pH**
- **Disease/ infection fighting**
- **Heating/Cooling**


10 ml
5 ml
PLASMA - 55% of Total Blood Volume
91% Water
7% Blood Proteins (fibrinogen, albumin, globulin)
2% Nutrients (amino acids, sugars, lipids)
Hormones (erythropoietin, insulin, etc.)
Electrolytes (sodium, potassium, calcium, etc.)
CELLULAR COMPONENTS - 45% of Total Blood Volume
Buffy Coat
White Blood Cells (7000-9000 per mm^3 of blood
Platelets (250,000 per mm^3 of blood
Red Blood Cells (RBCs)
About 5,000,000 per mm^3 of blood

# Classification of Connective Tissue (Chapt 4)



# Blood = connective tissue

**Hematocrit (centrifuge)**

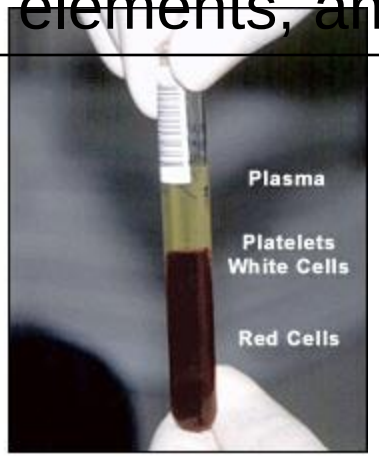
Extracellular fluid matrix:
**Plasma**

Cells: **(= Formed elements)**
**RBCs**
**WBCs**
**Platelets**

# Plasma Composition

- **Water ~92%**
- **Plasma proteins 7%**
- **Other solutes 1%**

Transports organic and inorganic molecules, formed elements, and heat



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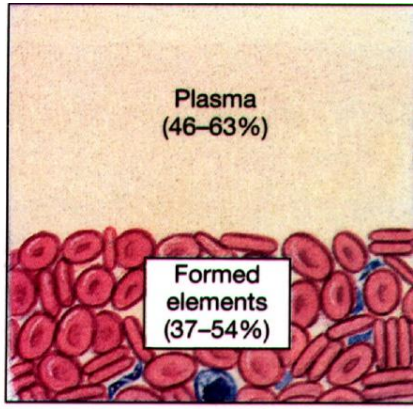



**Lavender Top Tube**

# Plasma Proteins (90% from liver)

- **Albumin (60%) Major contributor to osmotic concentration of plasma. Transport of lipids and steroid hormones**
- **Globulins (35%) Transport ions, hormones, lipids; immune function**
- **Fibrinogen (4%) Essential component of clotting system (conversion to insoluble fibrin) NOT IN SERUM**
  - **Anticoagulants (blood thinner), e.g. coumadin**
- **Regulatory proteins (< 1%) Protein-based hormones**
- **Lipoproteins = particles containing lipids (cholesterol & triglycerides) and proteins (albumins & globulins)**

# Plasma Solutes, cont'd

- **Electrolytes: Normal extracellular fluid ion composition**
- **Organic nutrients: glucose, FA, AA**
- **Organic wastes: urea, bilirubin**
- **Dissolved gases**
- **Nonprotein-based hormones**
  - **E.g., steroids**

# Plasma vs. Interstitial Fluid:

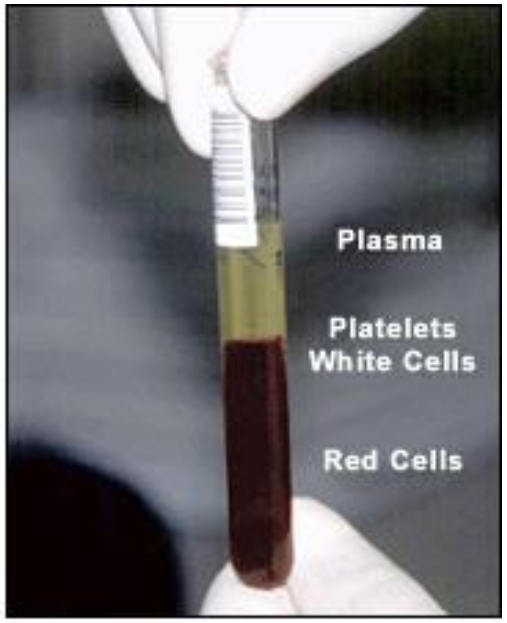
**Plasma has more:**

- Dissolved $O_2$ — $O_2$ diffuses out into tissue
- Dissolved proteins (too big to cross caps.)
  - Albumins
  - Globulins
    - $\gamma$ globulins
    - $\alpha$ and $\beta$ globulins
  - Fibrinogen

*Similar concentration: Salts & small molecules*

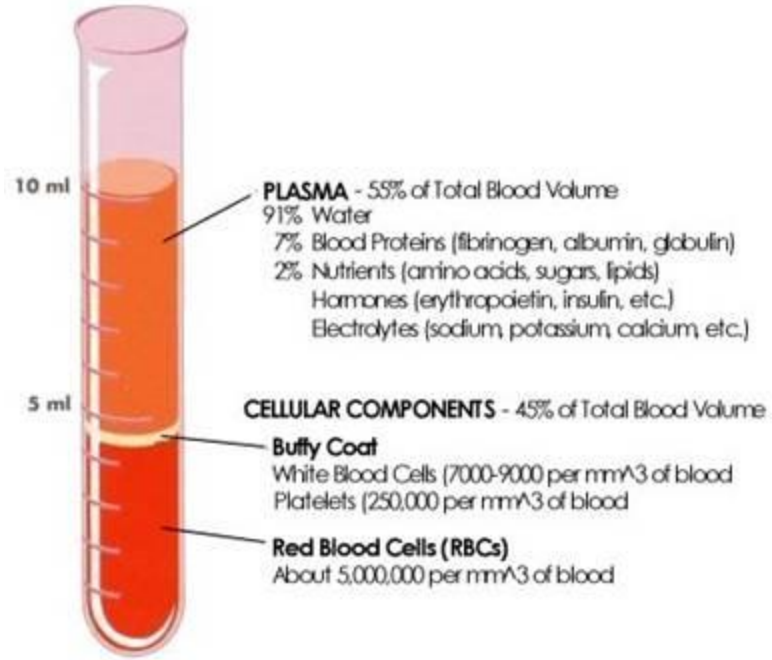
# Plasma vs. Serum:

**Difference between plasma and serum?**




**serum = plasma – clotting factors**

# Formed Elements (Cells)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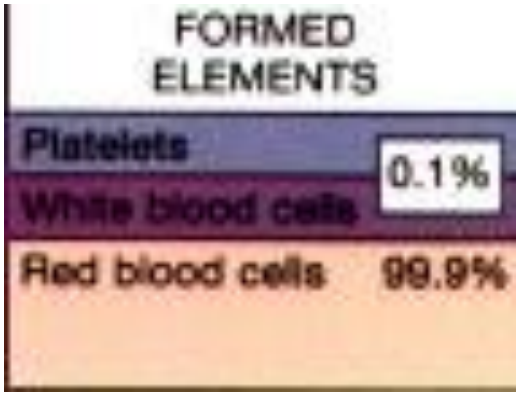
1. Red Blood Cells (> 99%)
2. White Blood Cells
3. Platelets

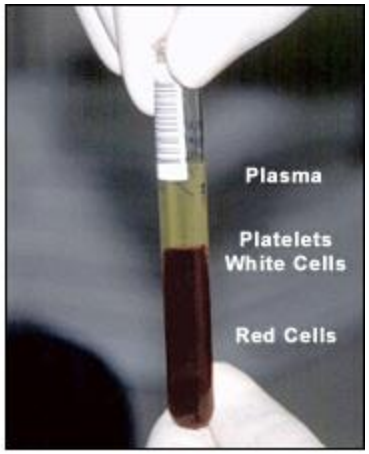
PCV = Hematocrit = % of the blood sample that is Formed Elements

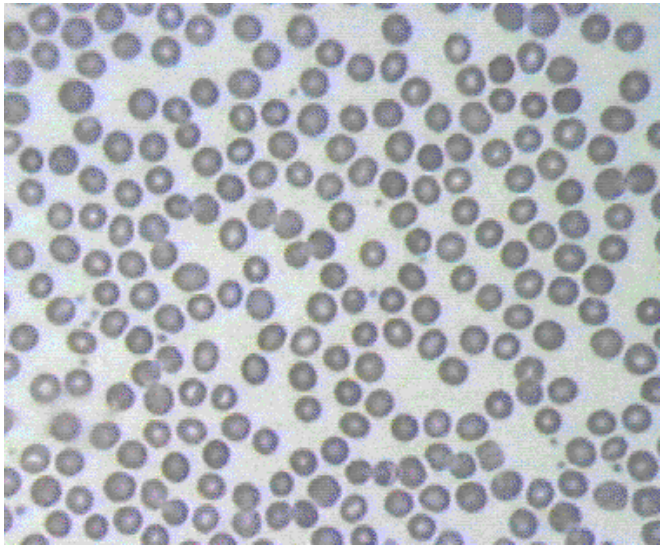
Man: 46%

Woman: 42%

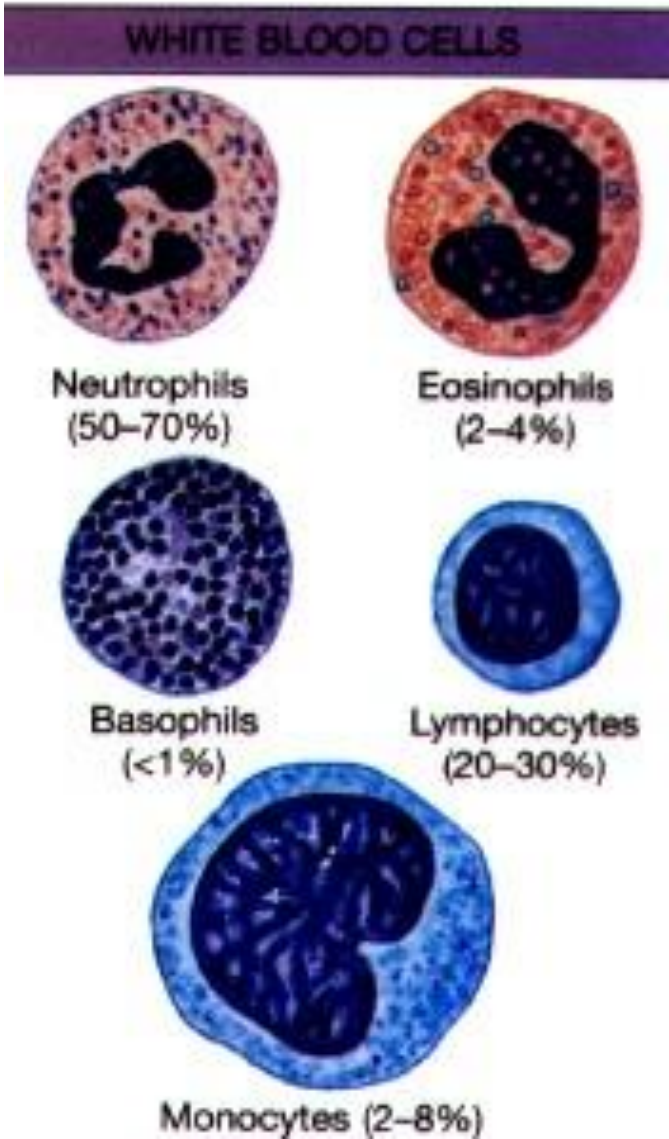
# Formed Elements cont'd.



Why **white** blood cells???



# RBCs = Erythrocytes

**Measured by hematocrit (PCV)**

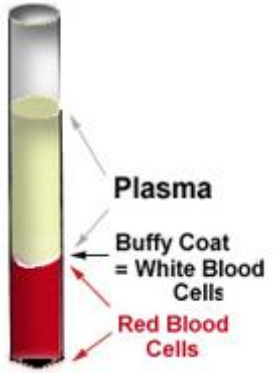
**Most abundant blood cell: 1000 RBCs/1 WBC**

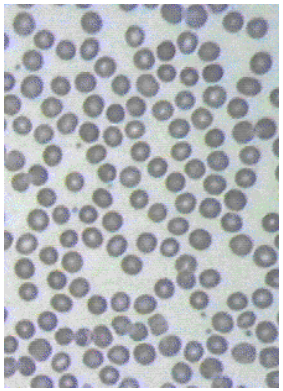
**Contain hemoglobin (Hb), carry oxygen**

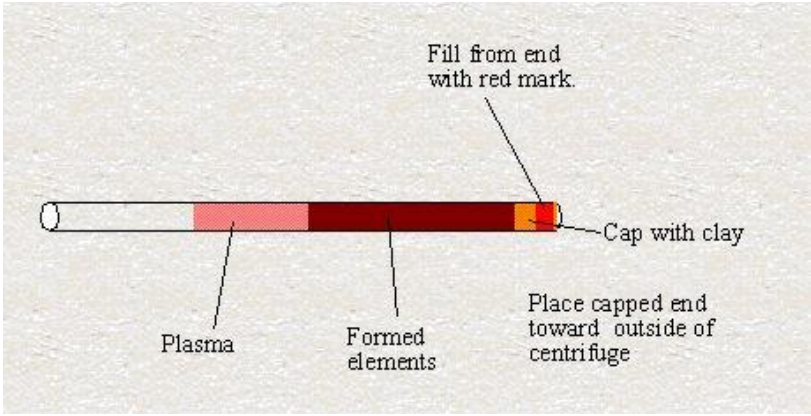
**No organelles, just Hb**

**Lifespan ~ 120 days replacement rate**

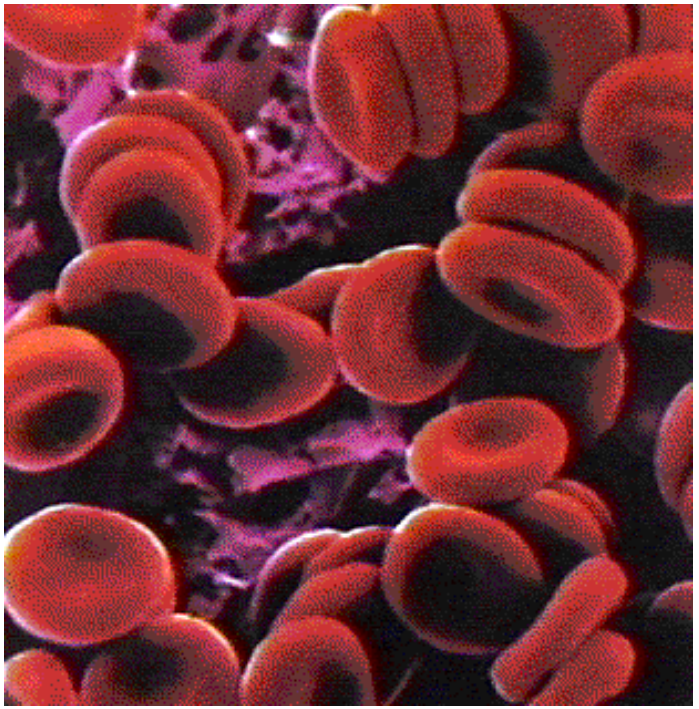
**~ 3 x $10^6$ RBCs / sec**



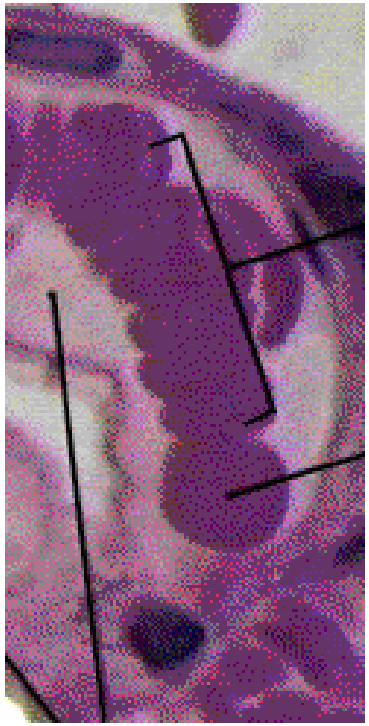


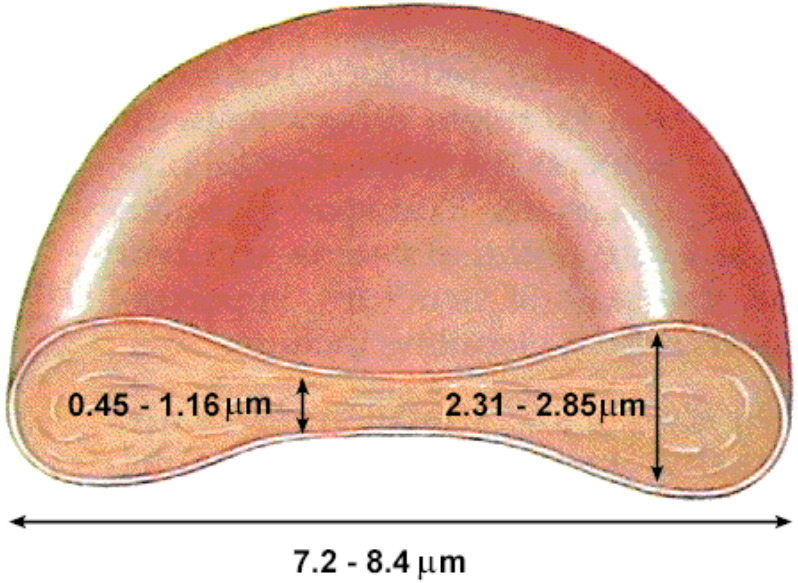
# RBC Shape



**Biconcave Disc,** 7 µ (good measuring device)

1) Larger surface area
2) Flexible

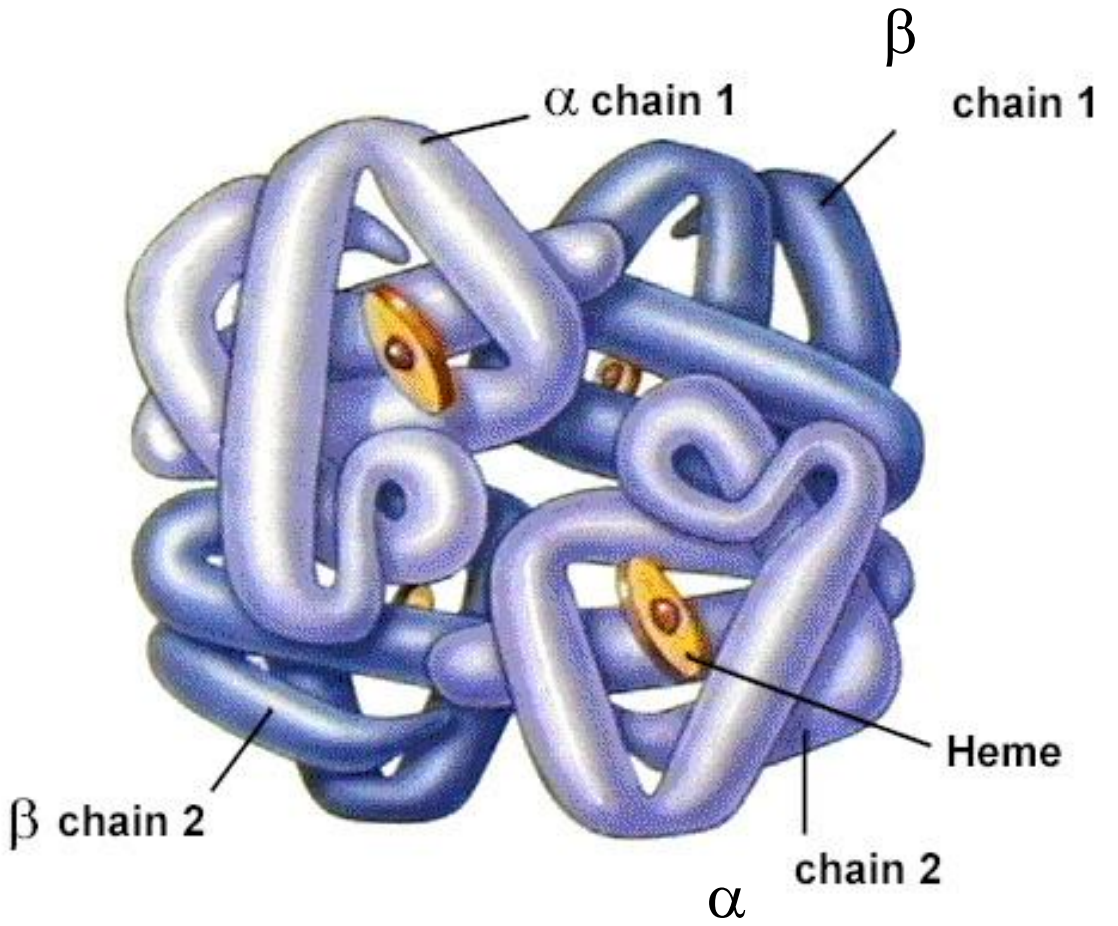




# Structure of Hemoglobin (Hb)

***Fe ion*** **in heme group reversibly binds $O_2$**

**How many oxygen molecules can 1 Hb molecule carry? 4**



# Clinical Brief

## Anemia:

**Reduced oxygen carrying ability of blood.  Causes??**

## Polycythemia:

**Erythrocytosis: excessive increase in RBCs**

**Polycythemia vera:**

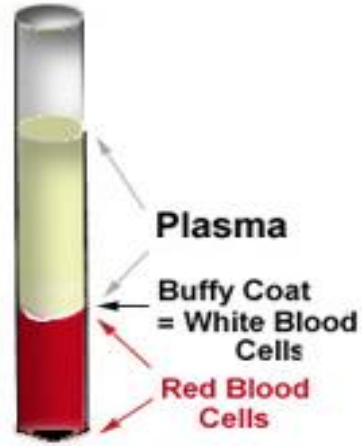
## Blood Doping:

**Via direct transfusion, or**

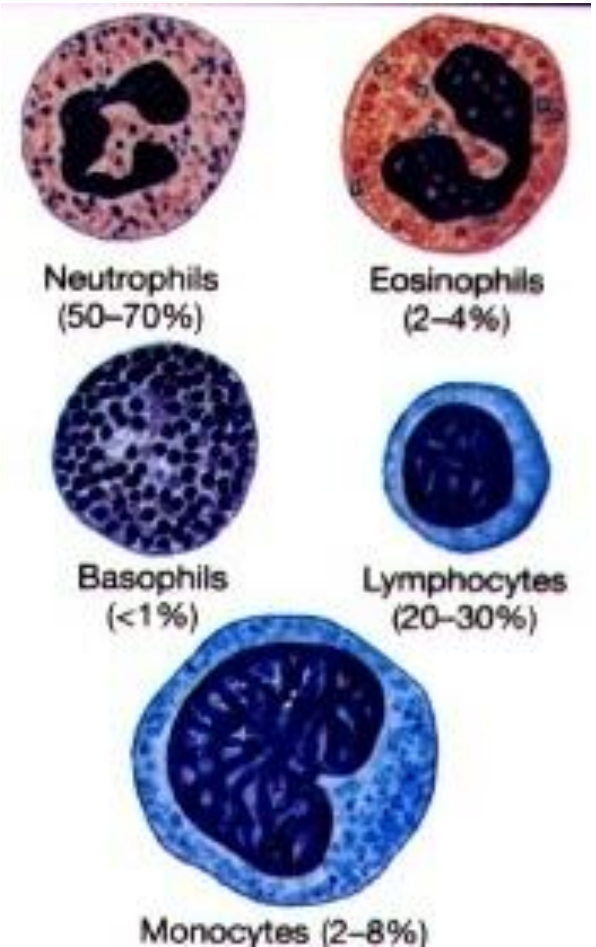
**EPO use**

# WBCs = Leukocytes p542

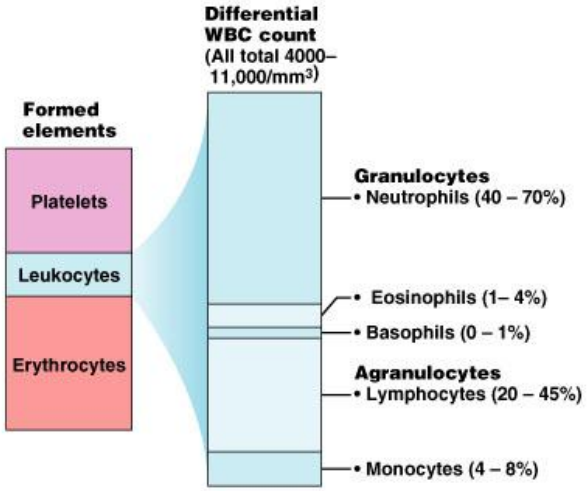
- Quantity and type determined by differential WBC count
- Circulating WBCs are only a small fraction of total WBCs. Most are located in interstitial tissues
  - Diapedesis
  - Chemotaxis
- Five different kinds:
  - Three Granulocytes
  - Two Agranulocytes



**Granulocytes and Agranulocytes**



# WBCs = Leukocytes

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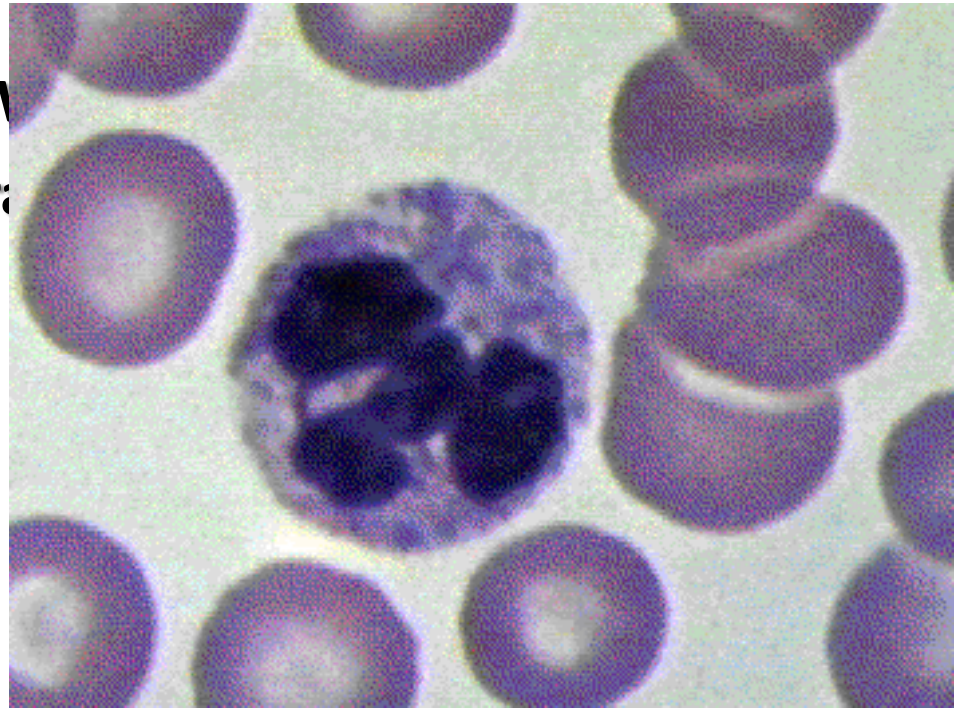
# 1) Neutrophil (= PMN)

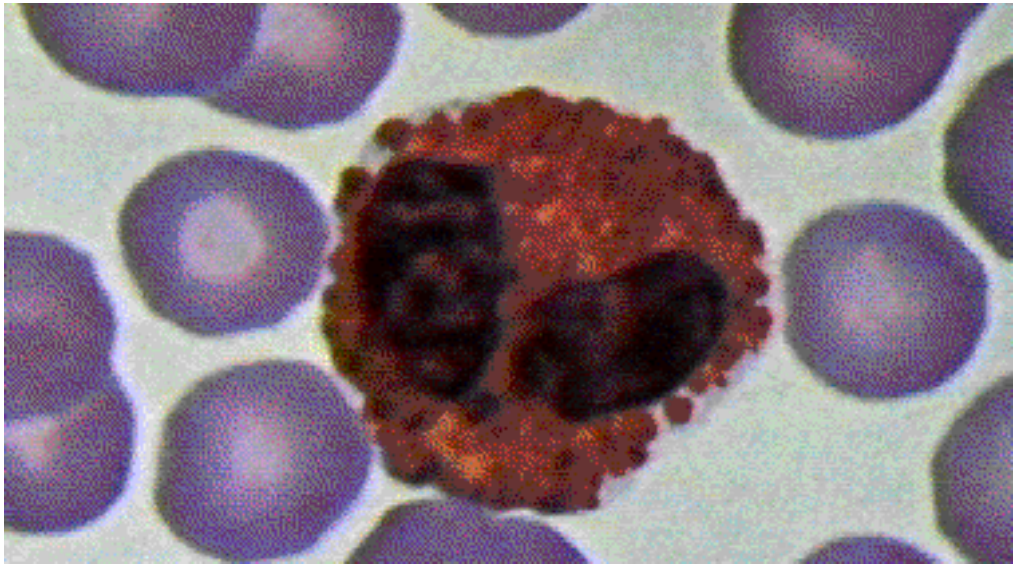
**PMN = polymorphonuclear leukocyte = poly = seg**

- **~ 60-70% (~ 2/3) of circulating W**
- **Cytoplasm packed with pale gra containing lysosomal enzymes**
- **Phagocytic**



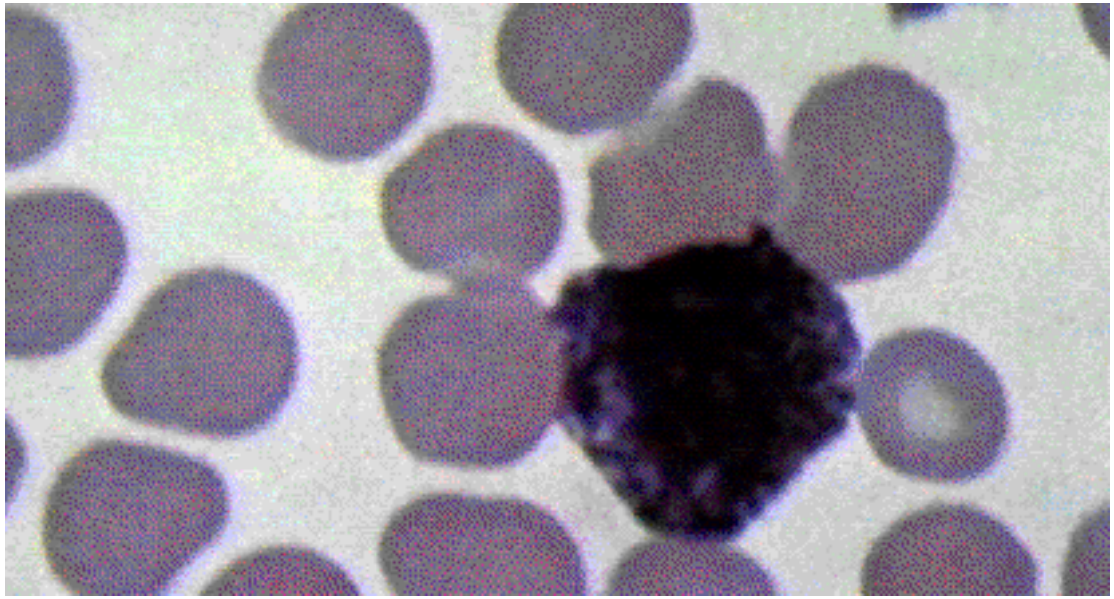
# 2) Eosinophil

- **~ 2% - 4% of circulating WBCs**
- **Granules stain with acidic dyes (eosin), look reddish**
- **Increased in allergies and parasitic infections**



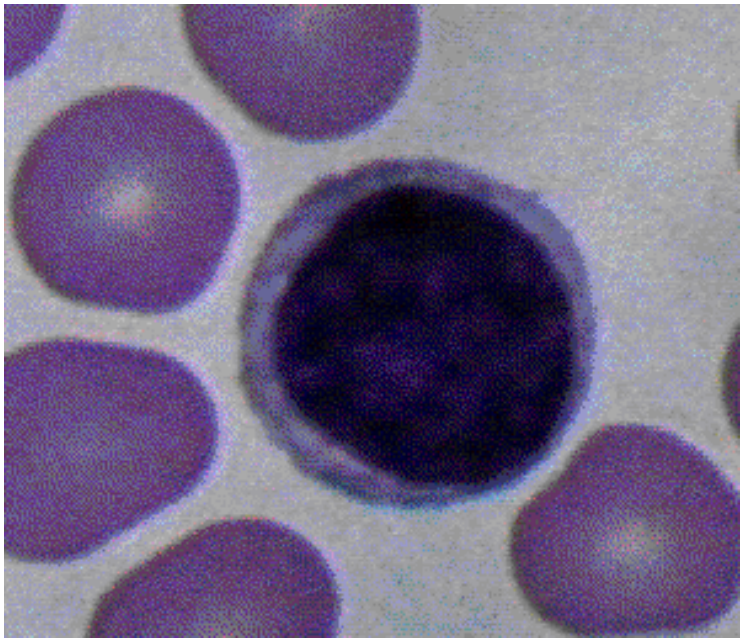
# 3) Basophil

- **< 1% of circulating WBCs**
- **Granules stain with basic dyes (hematoxylin) and contain histamine**
- **Discharge of histamine promotes inflammation at site of injury**



# 4) Lymphocyte (chapt 21)

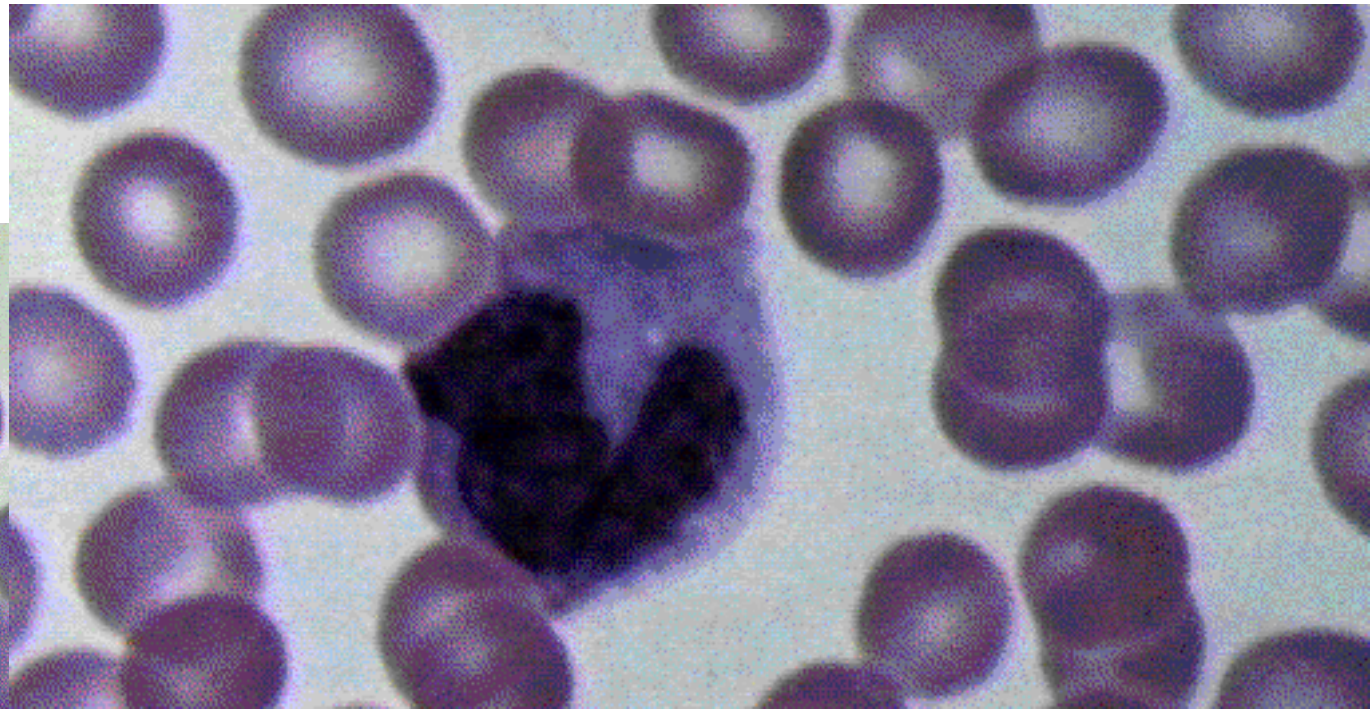
- ~ 20% - 30% of circulating WBCs
- Relatively small (slightly larger than RBCs, smaller than PMNs)
- Large round nucleus, not much cytoplasm
- Mostly found in tissues
- Types
  - B lymphs become plasma cells
  - T lymphs attack directly
  - NK recognize “lack of self.”



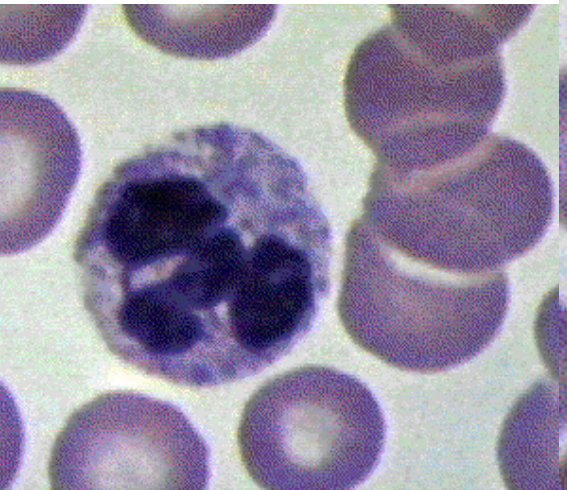
# 5) Monocyte

- **~ 2% - 8% of circulating WBCs**
- **Large kidney (or U) shaped nucleus**
- **In tissue, called Macrophage**

**Macrophage**



**PMN**



# Platelets = Thrombocytes

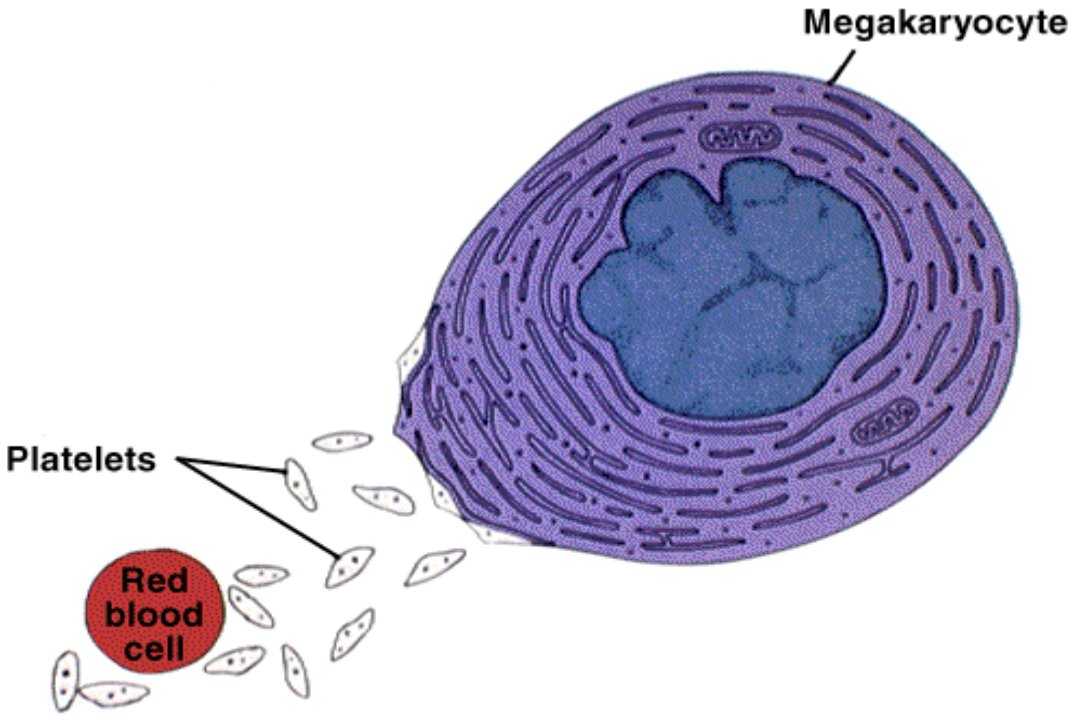
Cell fragments of megakaryocytes of bone marrow

(~ 4,000 thrombocytes per megakaryocyte)

∅ ~ 160 μm

Lifespan ~ 12 days

involved in blood



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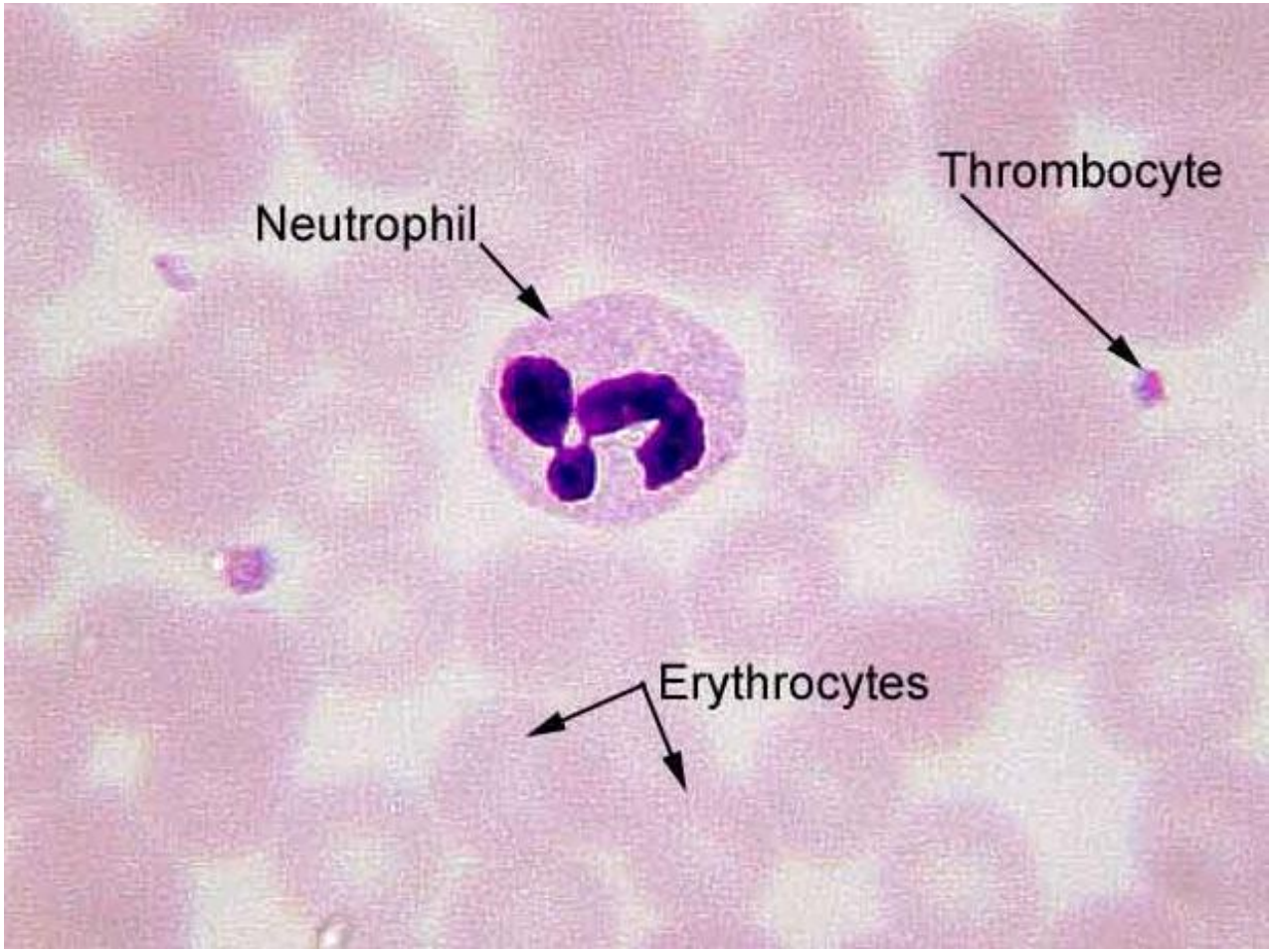
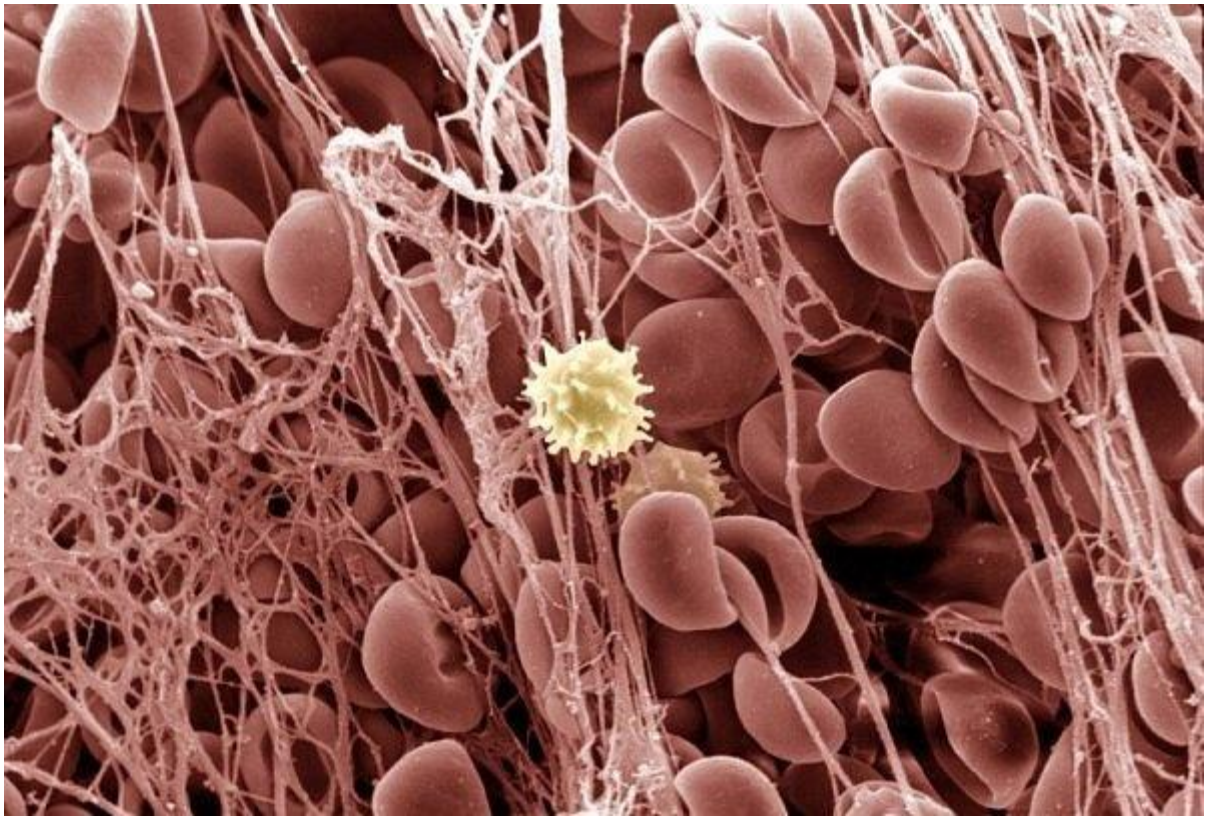


# Clotting Mechanism



# Abnormal White Blood Cell Counts

Leukopenia < 2,500/ μL (normal 6000 – 9000)
Leukocytosis > 30,000/ μL

Thrombocytopenia: < 80,000/ μL (normal ~ 350,000)
Thrombocytosis: > 1,000,000/ μL

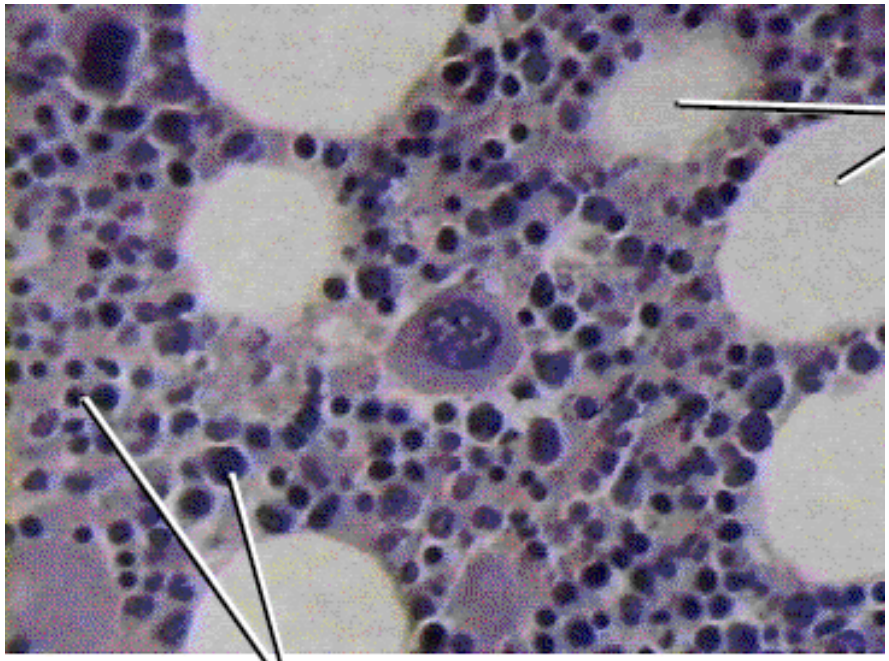
*Also*
Lymphopenia vs. lymphocytosis
Neutropenia vs. Neutrophilia

Leukemia

# Hemopoiesis

= **Blood Cell Formation (Red marrow)**

**Hemocytoblasts:** One type of stem cell for all blood cells



Developing erythrocytes and granulocytes

. . . then differentiation into 4 types of progenitor stem cells:

- Erythroblast
- Myeloblast
- Monoblast
- Lymphoblast

# Hemopoiesis

Pluripotent Stem Cell

-blast Cells

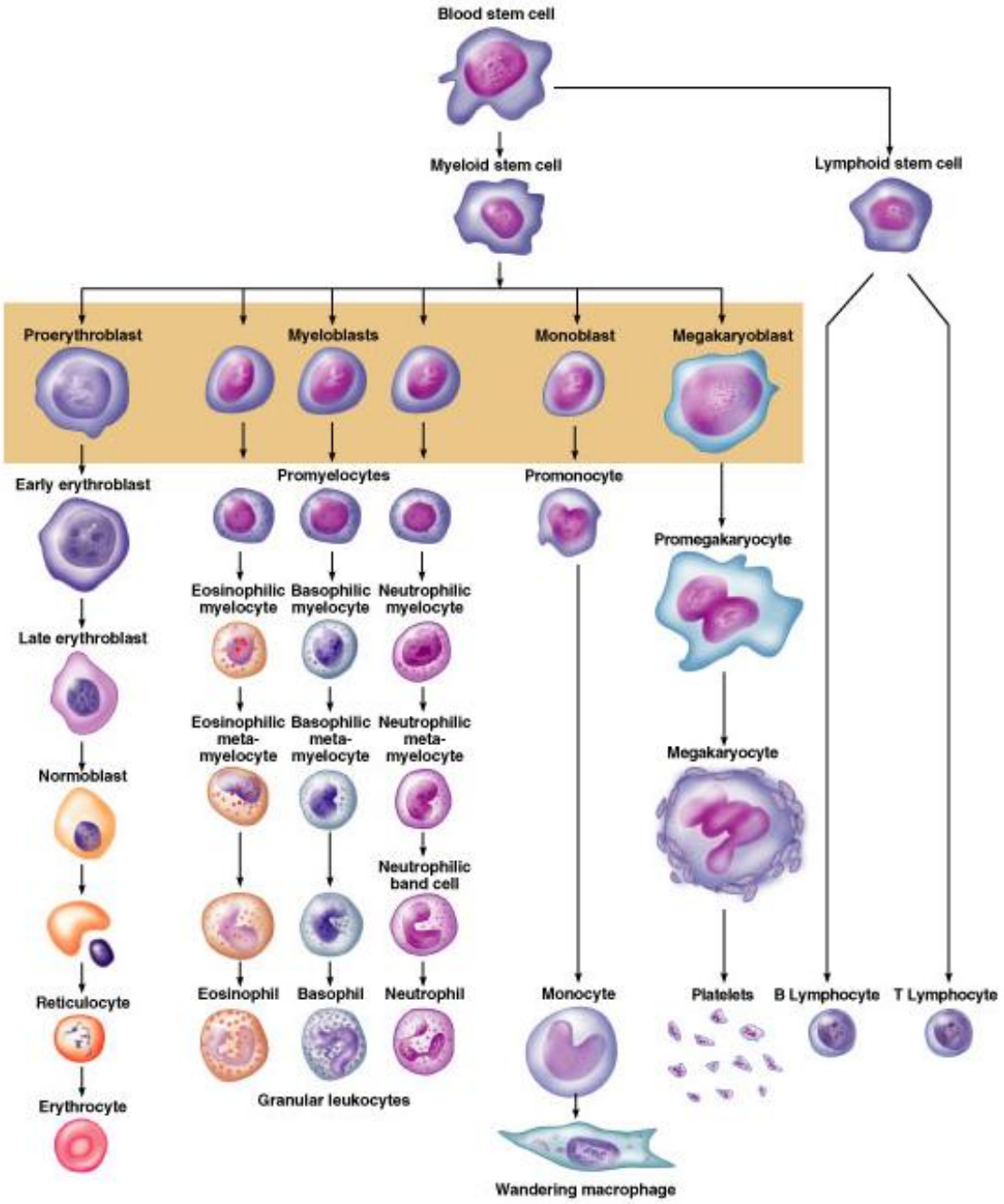



Fig. 17.8